國立臺北科技大學102學年度碩士班招生考試

系所組別：2403 光電工程系碩士班

第三節　近代物理　試題（選考）

注意事項：

1. 本試題共 5 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

electron mass $m_e = 9.11\times10^{-31} kg$　　electron charge $e = -1.6\times10^{-19} C$

Boltzmann constant $k_B = 1.38\times10^{-23}$ J/K　Planck constant $h = 6.63\times10^{-34} J\cdot s$, $\hbar = \frac{h}{2\pi}$

light speed $c = 3.0\times10^{8} m/s$

1. The light of total intensity $4.0\mu W/cm^2$ falls on a clean iron sample of $2.0cm^2$ in area. Assume that the iron sample reflects 90% of the light and only 5% of the absorbed energy lies in the region of spectrum above the threshold frequency.
   (a) What intensity is actually available for the photoelectric effect? (8%)
   (b) Assuming that the average wavelength of the photons in the violet region is 240nm, how many electrons will be emitted per second? (7%)
   (c) Find the work function for iron with the threshold frequency $1.2\times10^{15} Hz$. (8%)
   (d) The photoelectrons are produced by the violet light of wavelength 240 nm. Find the stopping voltage to stop all photoelectrons. (7%)

2. An electron with speed 0.85c, find
   (a) its total energy in electron volts, (5%)
   (b) its kinetic energy in electron volts , (5%)
   (c) and its de Broglie wavelength.(5%)

3. According to the Stefan-Boltzmann law, the power $R(T)$ (per unit area) emitted from the blackbody surface at temperature T can be written as $R(T) = \sigma T^4$ with $\sigma = 5.67\times10^{-8} Wm^{-2}K^{-4}$ The radius of the sun is $7.0\times10^{5} km$ and the mean Earth-sun distance is $1.5\times10^{11} m$. Assuming that the sun is a blackbody and the surface is at temperature 6000K, find the power per unit exposed area received by the earth. (10%)

4. For a hydrogen atom, the lowest stationary state has energy $E_1 = -13.6eV$.
   (a) Calculate the energy of the states corresponding to the principal quantum number n=3 for a hydrogen atom. (5%)
   (b) Enumerate **all states** of the hydrogen atom of n=3 by spectroscopic designation (n, l, m_l) for each state, where n, l, and m_l are principal quantum number, orbital quantum number and magnetic quantum number respectively. (10%)
   (c) Consider an electron in the sate of (n, l, m_l)=(3,2,m_l).
   (c1)Calculate the magnitude of the total angular momentum $|L|$, and express it in terms of $\hbar$, where $\hbar = h/2\pi$ (h is Planck constant) (5%)
   (c2)Calculate all the allowed values of L_z, and express them in terms of $\hbar$, where $\hbar = h/2\pi$ (h is Planck constant) (10%)

5. **Stern-Gerlach experiment** but using hydrogen atoms. The atomic hydrogen beam was produced in a discharge tube having temperature of 600K. The highly collimated beam passed along the x direction through an inhomogeneous field of length 4 cm having average value of 1250 T/m along z direction. The magnetic moment of the hydrogen atom is 9.27×10^{-24} J/T. The Boltzmann constant $k_B = 1.38\times10^{-23}$ J/K and the mass of the hydrogen atom is 1.67×10^{-27} kg.
   (a) What is the root-mean-square speed of the hydrogen atom in the discharge tube? (5%)
   (b) The atomic beam is detected on a collector plate after passing along the inhomogeneous field. What is the separation of the atomic beam on the plate? (10%)